SOURCES OF WATER POLLUTION[1]

By John W. Hill

From personal experience the writer came to a realization of some of the difficulties in obtaining satisfactory sources of water supply for many of the smaller and some of the larger cities and towns in the state. There are many settlements in Ohio which have grown into populous villages and cities by reason of local conditions which have affected their prosperity, and when they have reached the size and dignity of a large village, or a small city, and sought to obtain the usual sanitary conveniences now considered as essentials of populated centers, have found that there was no convenient source of public water supply, or convenient and safe point of disposal for sewage, both of which are essential to the life and growth of any considerable village or city today. Other problems with respect to the disposal of city wastes also arise as villages and cities grow in numbers and density of population; but the chief and first problems are an adequate and safe water supply, and a convenient and safe method of disposing of village and city sewage.

The sources of public water supply in this state are low level lakes, like Lake Erie, rivers, creeks, wells and impounded water. There are a few small natural lakes at high elevation in the state, from which water can be drawn by gravity; but with no exception can such water be considered wholesome and safe for drinking purposes in its natural condition.

Water from Lake Erie, the Ohio River, or any other river or creek in the state, cannot be used in safety to health without some artificial purification. This fact is recognized now, although it was not a few years ago. There may be some spots in Lake Erie, far removed from its shores, where the water is safe for domestic purposes, but these spots are not within practicable reach, and may not at all times be safe. The lake is shallow and simply a wide stream for the discharge of all the polluted water that reaches it from the other three Great Lakes and numerous sewage polluted rivers and

[1] Read at meeting of Central States Section.

creeks which discharge into it. In addition to the sewage from municipalities and other land sources which reaches the lake, there is the constant discharge of sewage from the vessels which traverse it. So that if there are sources in the lake from which a safe water supply can be drawn today, there can be no assurance that the source will be safe tomorrow.

Safety is here meant to apply to water for drinking and domestic uses, and not to water for commercial purposes, or for flushing sanitary appliances. Water for the bath and the lavatory should be free from infectious organisms, if it is to be used without risk to health.

Driven wells, if the yield of water is sufficient, are generally regarded as our best sources of public water supply in this part of the country, but care must be exercised that the naturally pure water at the bottom of a driven well is not polluted and cannot become polluted by organic and perhaps infectious matter from surface and ground sources.

A short time since there came under the writer's observation the case of a water supply from driven wells which furnished some new and interesting information. A tube well had been driven to a depth of 120 feet, tested for capacity, found to yield a satisfactory volume of water, and samples of the water when analyzed were in all respects excellent. A second well located 250 feet distant, driven to the same depth, through the same strata, into the same water bearing sand, when tested for water quality was found to be of about the same chemical and physical character as the water from the first well, but contained in all samples abundant colon bacilli and showed decided sewage pollution.

The first well was satisfactory as a source of domestic water supply, the second well was not, and yet from all outward appearances there was no reason why there should have been any difference between the sanitary analyses of samples of water from the two wells 250 feet apart and driven into the same water bearing strata. There was a difference, however, the cause of which was not discovered by the state board of health. The first well when tested was pumped to a point of discharge where it flowed away in surface channels, which were not in connection with the water bearing strata from which the water was drawn, and the test samples collected from the unpolluted source 120 feet below ground level. The water from the second well upon pumping for yield was discharged into

an abandoned and forgotten privy vault, about 12 feet from the well, not known to the officials in charge of the work, and from this vault, or cesspool, the colon bacillus was carried through the porous strata to the drive pipe of the well and mixed with the water from the strata which furnished the well supply, and came to the surface by pumping, and was found in the test samples of water taken for analysis.

There was thus established a circulation of water, from the unpolluted source to the abandoned vault, and from the vault through the porous earth and drift materials to the strainer at the bottom of the drive pipe, the water from the test pump percolating through the disturbed drift materials alongside the drive pipe to the safe strata below, and in this manner polluting what was naturally an excellent water source.

Surface sources of water, excepting from uninhabited mountain districts where there is no domestic animal life which can impart a taint to the runoff from rainfall, cannot be regarded as safe for drinking purposes without purification by artificial means. Epidemics of typhoid fever have been traced in Switzerland and in this country, to water impounded from the rainfall and runoff on grazing lands, and this experience has led some profound investigators of the cause of typhoid fever to suspect that the colon bacillus from domestic animals when ingested with drinking water by the human system, may become the real typhoid bacillus as we find it in the urine or excreta of a patient, and in the human spleen of a cadaver. As great an authority as Prof. Ray Lankester has given some credence to this theory; while the late Dr. Edmund Rogers of Denver, Colorado, was inclined to believe from his own experience in the west, that typhoid fever can be contracted from a mountain water that had been polluted with the colon bacillus from domestic animals. So then the runoff from farm lands, aside from pollution from human sources, cannot be regarded as a safe water for drinking purposes, or for use in culinary operations. Health as well as sentiment prohibits it.

It is well known that the same kind of noxious excretions arise in farm houses as in city dwellings, and if these in any manner are disposed of so as to mix with and contaminate the runoff from the land around the farmhouses, they will pollute the water in some degree. Many farmhouses clustered together may be as much of a menace to the water running off from the lands, as will small vil-

lages which, as it is known, have furnished the germs for the origin of a typhoid fever epidemic in a community which has used such water for drinking purposes.

Impounded water in this state is seldom safe for domestic uses without filtration, or without the use of some germicide which is sure to destroy all possible pathogenic bacteria. Of all the sources of water supply possible in this state, water from deep tubular wells is the safest for sanitary uses. But nearly all the deep wells furnish hard water, which aside from organic infection, has objectionable properties which require consideration before it is acceptable for domestic purposes.

Water containing salts of lime and magnesia are difficult of use for laundry purposes, requiring that they should be "broke" or have the hardening salts precipitated before they can be conveniently used for this purpose. In the pioneer days the farmer made "lye" from hickory ashes on his own premises, and employed this to soften the "hard" well water when wash day came around. For steam purposes hard water is objectionable from the standpoint of coal economy, and sometimes is a source of real danger in boiler operations, by the deposition of lime and other salts on boiler tubes, thus impairing the circulation and perhaps sometimes leading up to boiler explosions. There is no corrosion from the deposited lime, but the safety, as well as economic effect of steam boilers, is dependent on a free and active circulation of the water around or in the tubes and flues, and the lining or covering of a boiler tube with a lime scale impairs the circulation.

Lime salts in drinking water contributes to "arterial sclerosis," or hardening of the arteries, by the deposition of calcareous matter in the blood vessels, rendering them brittle and liable to rupture under sudden increased blood pressure. This means that a man, if he values his life, as he grows older, if his drinking water comes from a limestone formation and is not artificially "softened" before he uses it, should be very careful not to get excited over the "tariff," the "European War," or the "McDermott" law, or it may result in partial paralysis, apoplexy, or the production of an "aneurism" by the rupture or stretching of a blood vessel rendered brittle or weak by the drinking of "hard water."

It will thus appear that a well water while absolutely safe from the infectious disease point of view, may contain other objectionable properties, which should be removed or counteracted before it will become in all respects safe for domestic and commercial uses.

Water softening apparatus is now so well exploited and so well understood that every public water works drawing from limestone sources should investigate the matter and adopt some approved method for removing the hardening salts from a well water supply before the water is sent through the mains to consumers. It should be borne in mind that water consumers who depend upon the public water supply are helpless in matters affecting water quality, and if you who own, operate, or conduct water works in the interest of a municipality do not look after these matters in the interest of your consumers, your consumers certainly cannot do it for themselves.

In early childhood, it is believed that a water containing marked quantities of lime, magnesia and sodium is good for the development of the bony system, for these and phosphates constitute the principal elements of the bones; but after the bones have reached their full development and no longer need nourishment, then an excess of lime and similar salts in the water may be a detriment to the human system, and a positive menace to life.

Iron similarly in excess in a water supply may enrich the blood too much in adult life and lead to boils and other kinds of blood poisoning, the blood then furnishing a favorable "nidus" for the germs of septic poisoning derived from the air, water, or from organic matter in decay. Sometimes a water rich in iron like "chalybeate water" may be necessary for people who are "anemic," but those in good health do not need it, and such water may work great harm to people who are otherwise in good health. Blood poisoning, as usually considered, is not a disease, but an accident, and the cause is not infrequently the use of water with iron in excess. The iron is in loose combination with other salts in water and is easily assimilated in the circulation, and largely increases the number of red corpuscles, and this may go to a point where the proper balance between the white and red corpuscles is disturbed, and the circulation is then easily susceptible to the germ of blood poisoning, which manifests itself in boils, carbuncles and in other ways.

The writer is not attempting to discuss a medical subject but to point out how a harmless metal, as usually considered, may be very harmful if found in excess in a drinking water. The iron content in a water, where found in conjunction with sulphate of lime, makes a thin hard scale on boiler tubes, and adheres to the iron tube like porcelain in a pan or kettle, is difficult to remove and reduces the efficiency of the heating surface of the boiler tube. Such a scale

cannot be cut out with ordinary tube cleaning "turbines" and often the only remedy when the scale reaches an objectionable thickness is to remove the tubes and insert new ones.

No one will willingly eat tainted food for fear of ptomaine poisoning, which, as we know, is often attended with fatal results. Why then should we drink a tainted water which is much more readily assimilated than solid food, and if under the law we are protected from foods unfit for human digestion, why should we not equally be protected from contaminated water supplies unfit for human ingestion? The state board of health in this and other states protects us as well as it can from dangerous public water supplies, but the chief work in this direction must be done by the men who are in control of the municipal and privately owned public water works of the state.

It is possible to drive a tube well through impervious strata to a reasonable depth alongside a reeking privy vault, and obtain a water wholly free from sewage contamination, but the risk is great and a safe thickness of impervious clay strata is so seldom found that the practice is not to be recommended, and safety lies in having such wells so far removed from sources of contamination that by no chance can surface pollution reach the water bearing strata penetrated by the well.

Ponds that are sometimes used as sources of water supply, while free from defined sewage pollution from animal or human sources, often contain algal growths which are productive of disease, although perhaps not of a fatal nature. Certain flora in stagnant ponds, or even in ponds with a slight current, impart odor and taste to the water and often are the cause of sickness due to the products of decay.

While this objection may not be serious from the health standpoint, nevertheless in some parts of the country and perhaps in this state, it has been the cause of considerable complaint and some real distress, and where such ponds are otherwise acceptable as sources of water supply, great care should be exercised to see that they are free from all algae by the application of copper sulphate, or some other chemical which will inhibit the growth of vegetation.

There may not be many ponds used as sources of water supply in Ohio, nor are there a great many that are capable of such use, and this objection is pointed out mainly to guard against an ill advised attempt to adopt some such sources in the absence of careful

investigation as to the character of the water and its probable influence on health. And where such ponds are liable to be used as sources of water supply, consideration must be given not only to the prohibition of floral life in and around the edges of the pond, but also to the probability of the water becoming at some time affected from the runoff from farmlands lying at higher elevation on the watershed, when the use of water from such a source will always require filtration, or some other effective method of purification.

If the filtration in such instances is accomplished by a so called mechanical, or rapid sand filter, with the addition of a chemical to form a coagulant to intercept the suspended matter on the beds of filter sand, or precipitate it in settling basins, this chemical with filtration or sufficient sedimentation, will also take care of any objection which may arise from the floral growth; although there may be a few instances, even in this state, where if the floral matter was not permitted to grow by the application of a proper chemical to the water such water might be used without filtration, or other mode of purification.

It will thus be seen from this brief statement that a selection of a source of water supply is not an easy matter, and particularly is it difficult where deep well sources are unavailable, or where the water thus obtained would be subject to other objections than those herein mentioned. For example, a water tainted with sulphur while safe from every other point of view, could not, and would not, be continuously used by any community, although a small amount of sulphur in the water might not be objectionable.

Water in falling on the earth and passing through the materials overlying the rock and through the fissures and pores in the stratified rock, dissolves and takes up more or less, of the mineral matter with which it comes in contact, and from this source is obtained lime, magnesia, sodium, iron and other salts which are found in water samples on analysis. Sometimes arsenic is found in water samples from mining operations, and this mineral, as we all know, is very dangerous to the human system.

In many instances, especially with small towns and cities where it seems extremely difficult to obtain satisfactory sources of public water supply, it would seem that this difficulty might be overcome, although perhaps at considerable expense, by selecting some sources from which a supply could be had large enough to meet the require-

ments of a number of such towns and cities, and provide that the pumping, and purification if required, shall all be done at one point, and the water then distributed to the various towns and villages requiring it.

Such source might in its natural condition be unfit for drinking water and other domestic uses, but when purified by some approved method, the water then would go to all the towns requiring it in a condition that would be safe to health, and if it happened to be a "hard" water it could be also softened at the point of collection and pumpage, when afterward it would also be entirely satisfactory for all commercial purposes.